Reactor Data at Your Desk

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Joe Reyenga

NIST

August 8, 2013

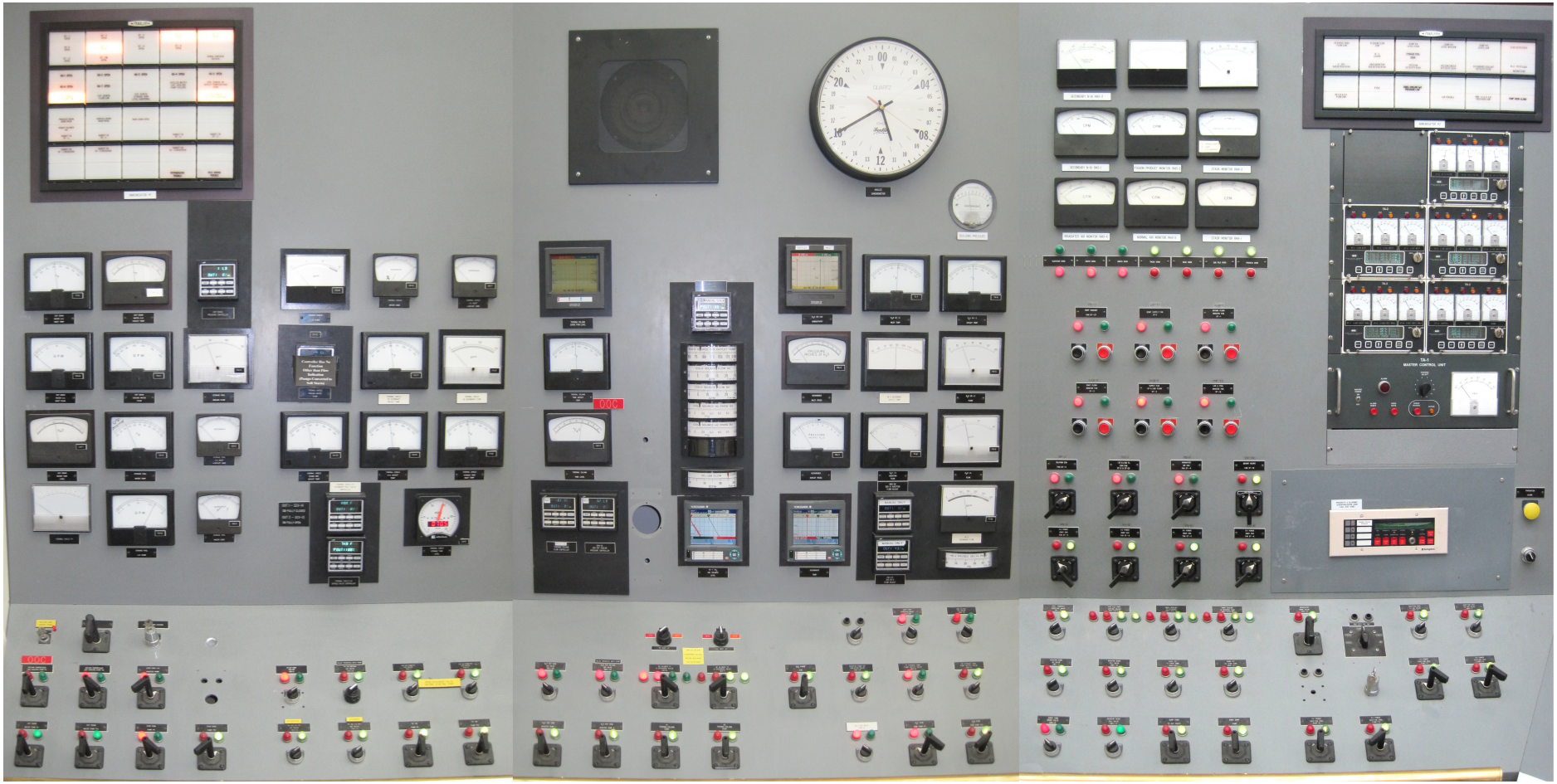
1. Control Room Upgrade
   - The Console
   - PAC Room
   - Data on the Network

2. Desktop Application
   - Data I/O With MySQL
   - Mimics
   - Historical Data
   - Extensions

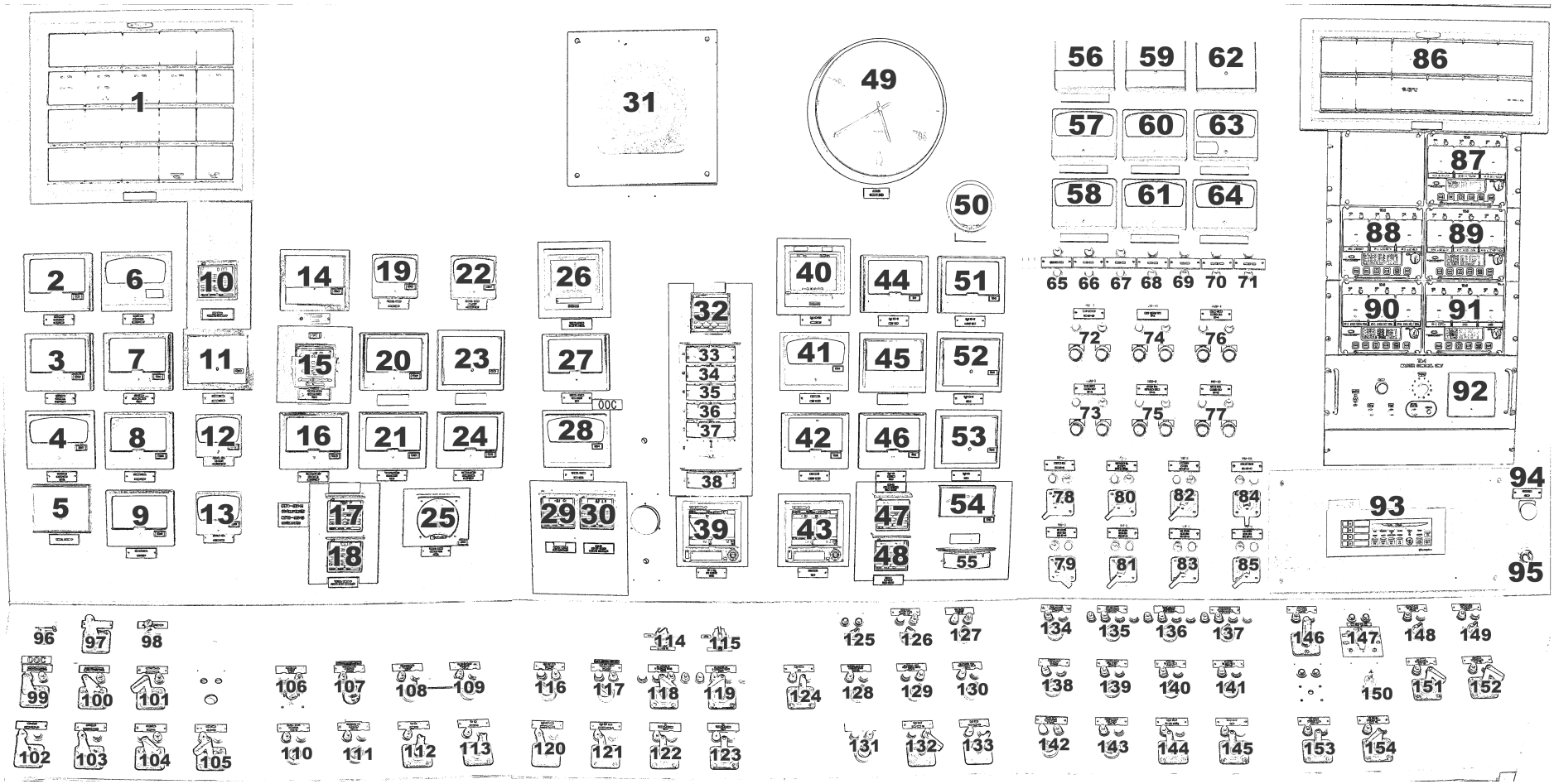
Introduction

Goal: Consolidate and display real-time and historical trend data from the reactor console so that operations and engineering can access it at their desk.

The Console



The Console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- Boolean indications are hard-wired to their respective components.
- There are hundreds of indications.

Digitization of Data

The analog (current-based) signal is converted to a stream of bits. This digital signal is transfered via Ethernet.

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- Direct console data goes through a Modbus read-only firewall.
- Other data is acquired from the PAC panels.
- Data is consolidated on a central Ethernet switch.

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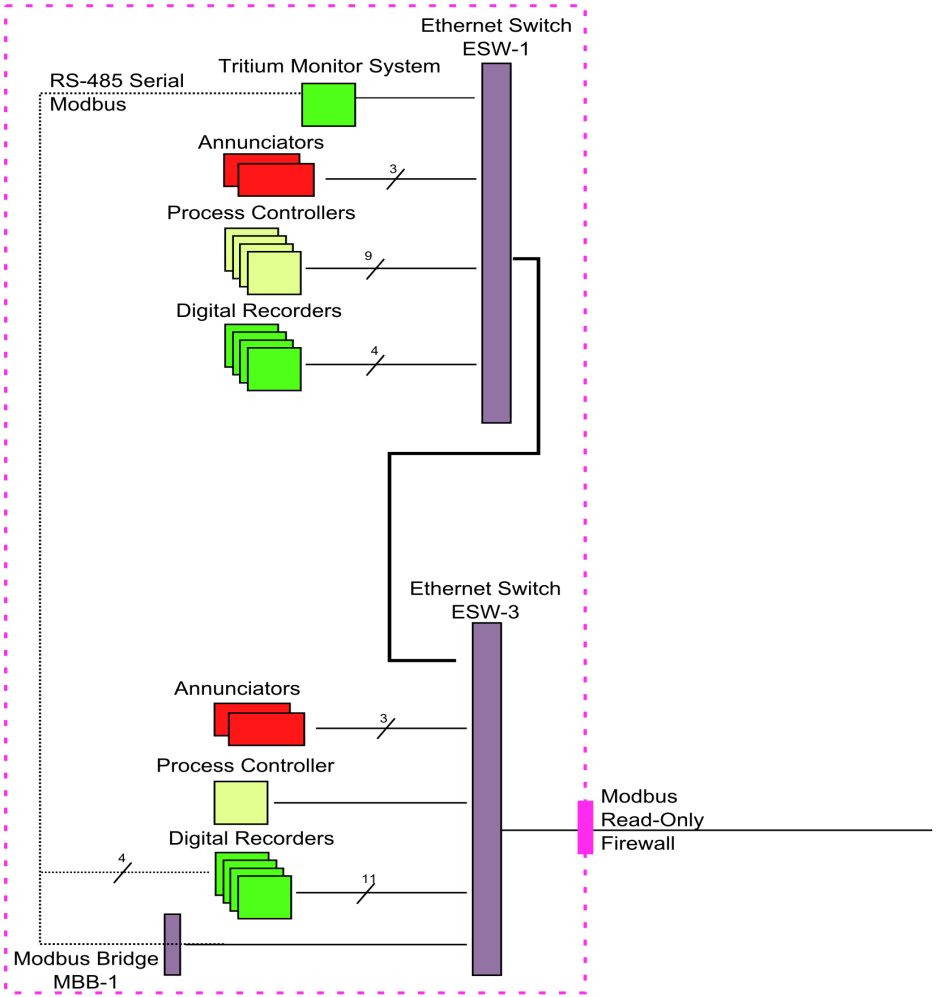
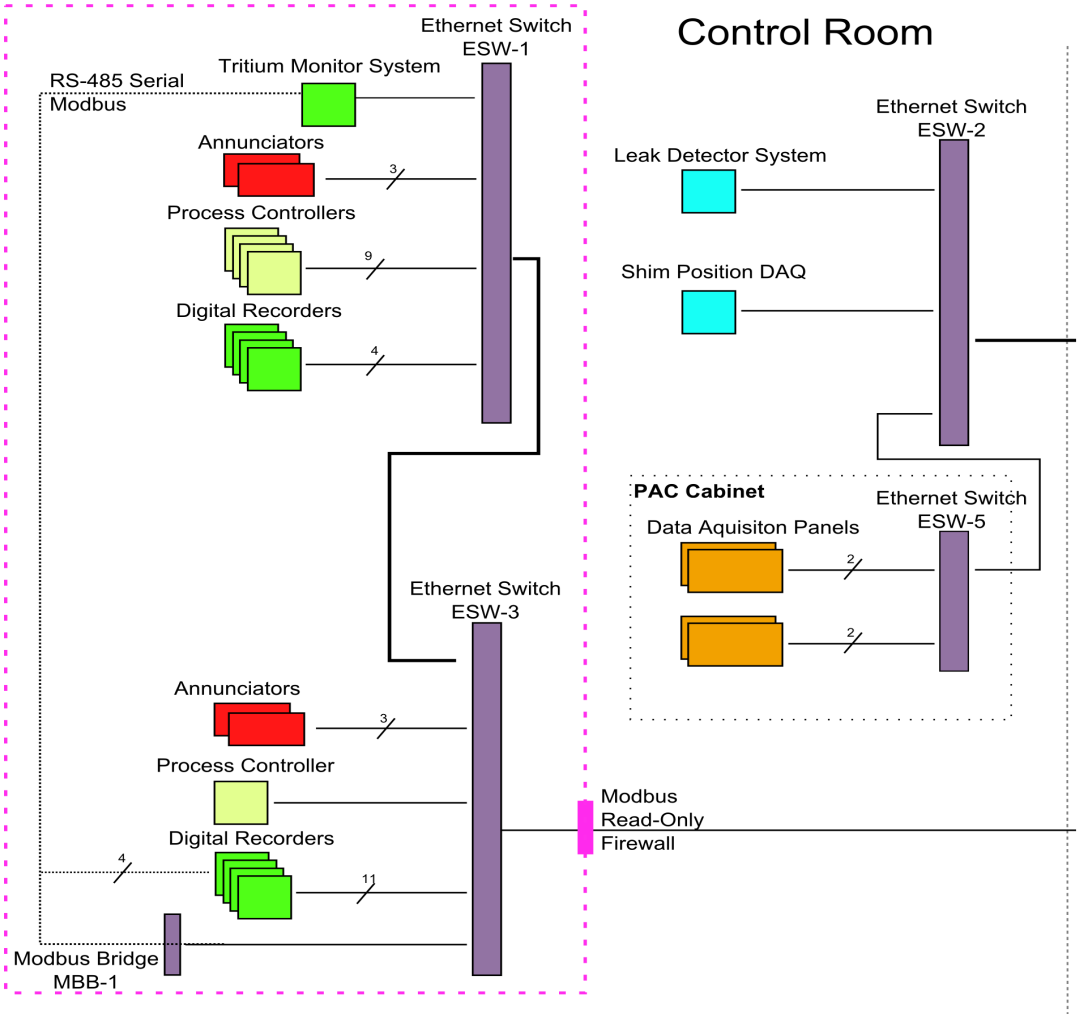
Network Architecture



Process Automation Control (PAC) Room

Network Architecture



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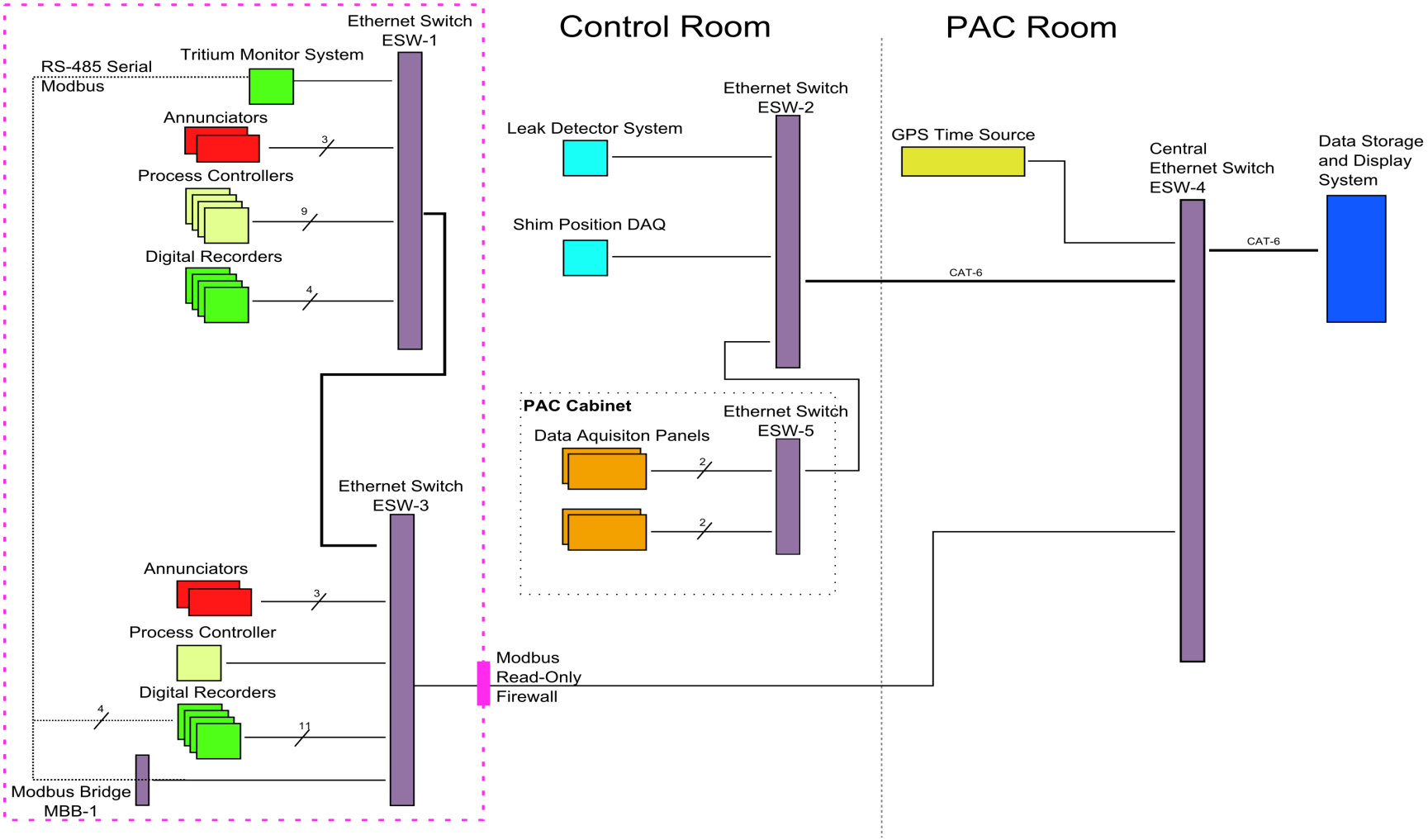
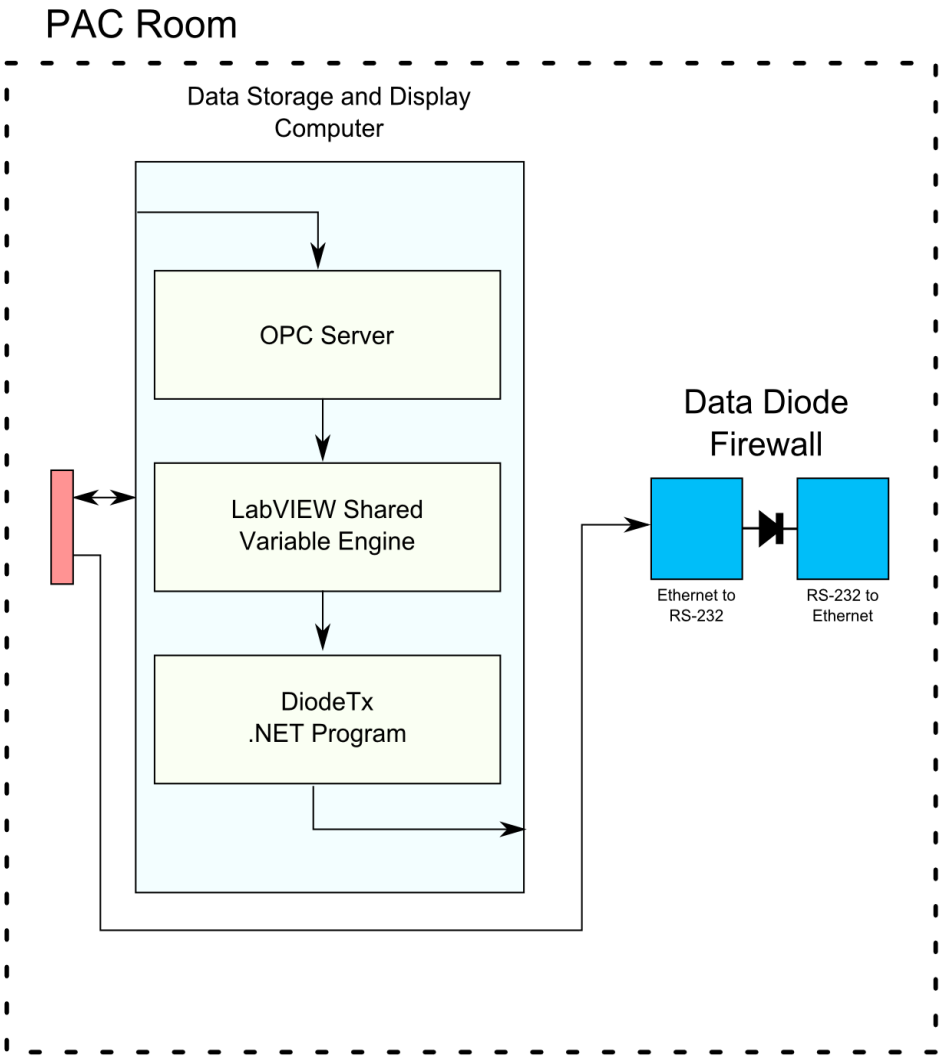


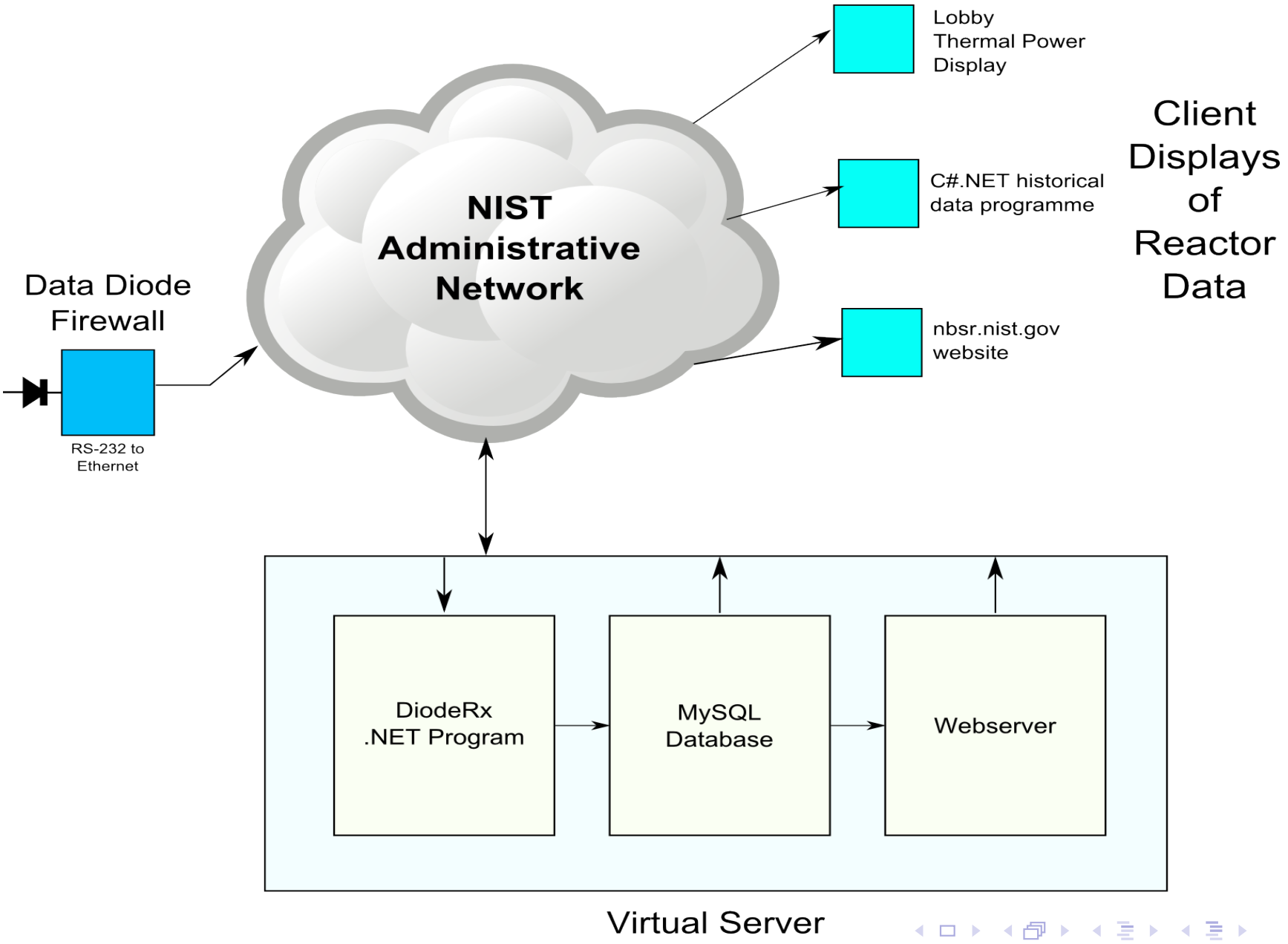
Process Automation Control (PAC) Room

PAC Computer

- Running National Instruments OPC Server and Citadel database.
- Data is displayed on the screens via LabVIEW.
- Data subset is formatted and pushed through the data diode every 2 seconds by the DiodeTx program.



Data on the Network



Storing Data on the Virtual Server

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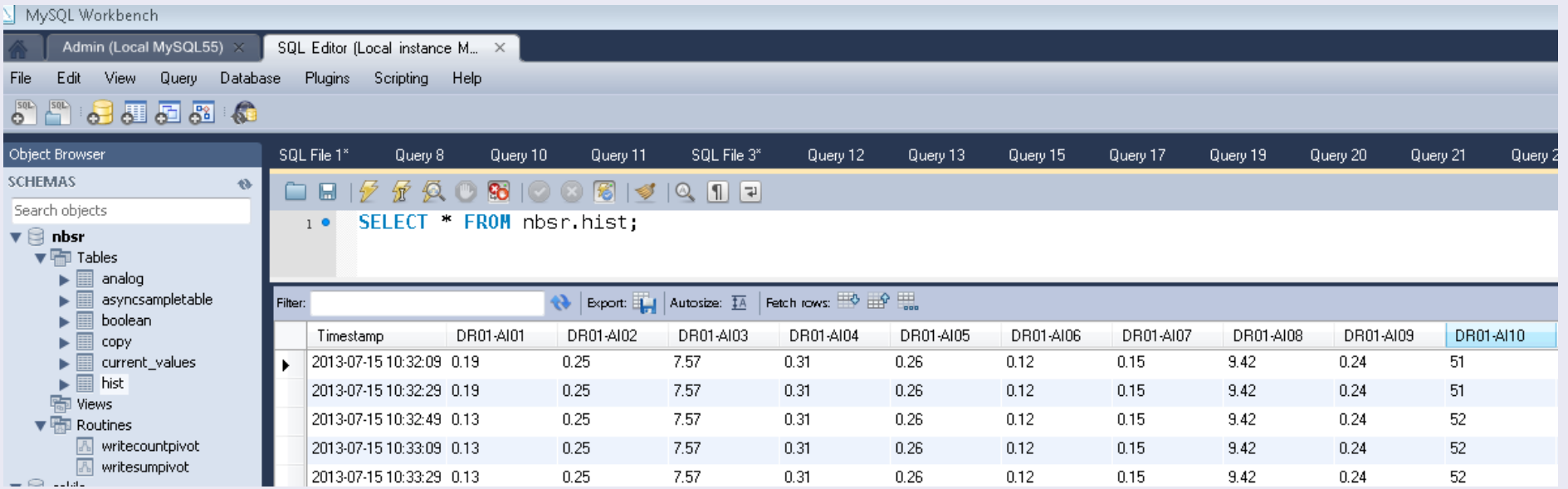
MySQL Workbench



Accessing Data from the Virtual Server

- The C#.NET program translates user input into queries mySQL understands, and mySQL returns the data.

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Sample SELECT statement in C# code

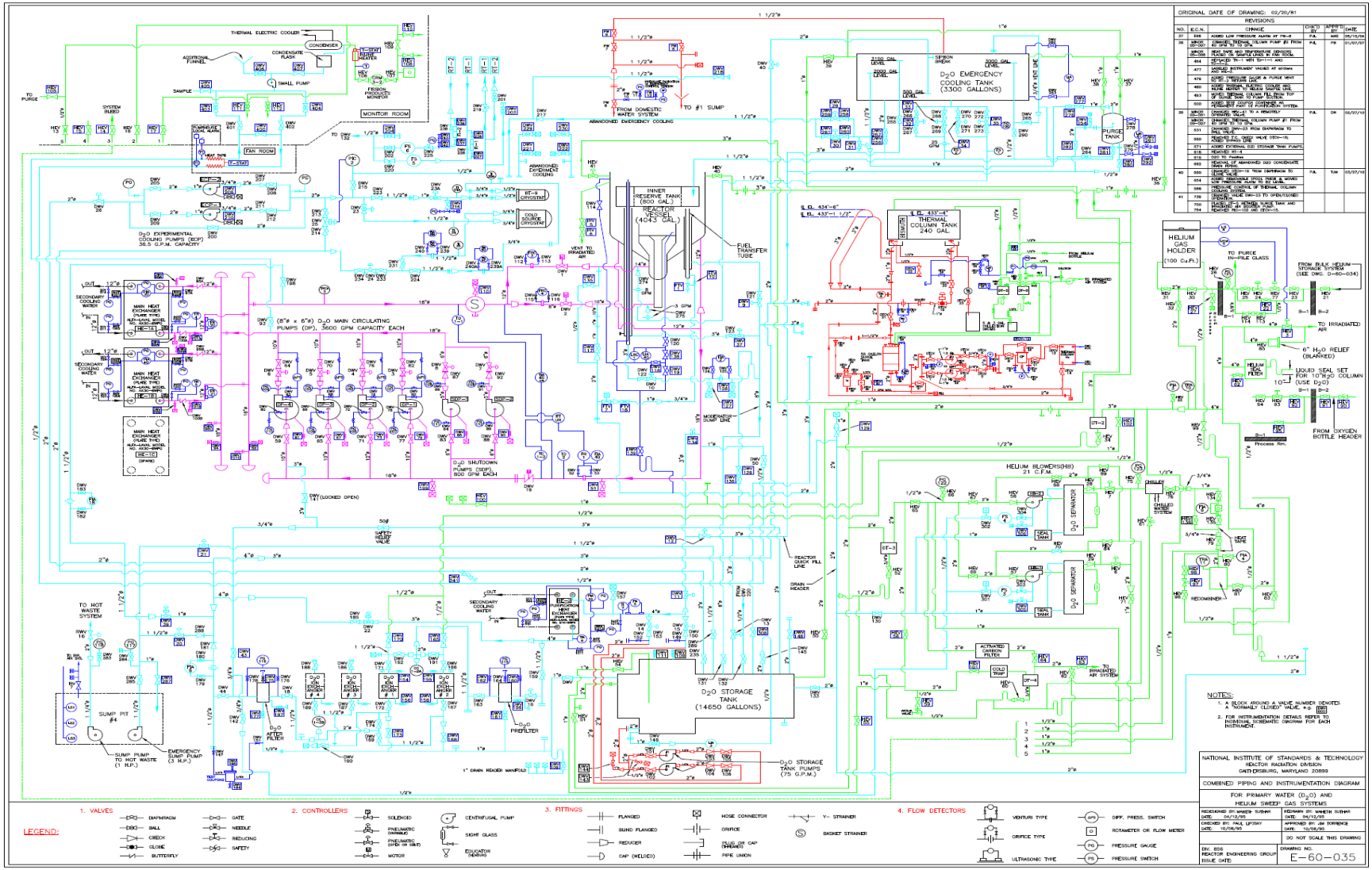
```
string query = "SELECT `" + tag + "`, Timestamp FROM
nbsr.hist WHERE `" + tag + "` NOT REGEXP 'NaN' AND `" +
tag + "` IS NOT NULL AND Timestamp>'" + lowTimeLimit + "'
AND Timestamp <'" + upTimeLimit + "'";
```

Displaying Data

- How should all of this reactor data be displayed?

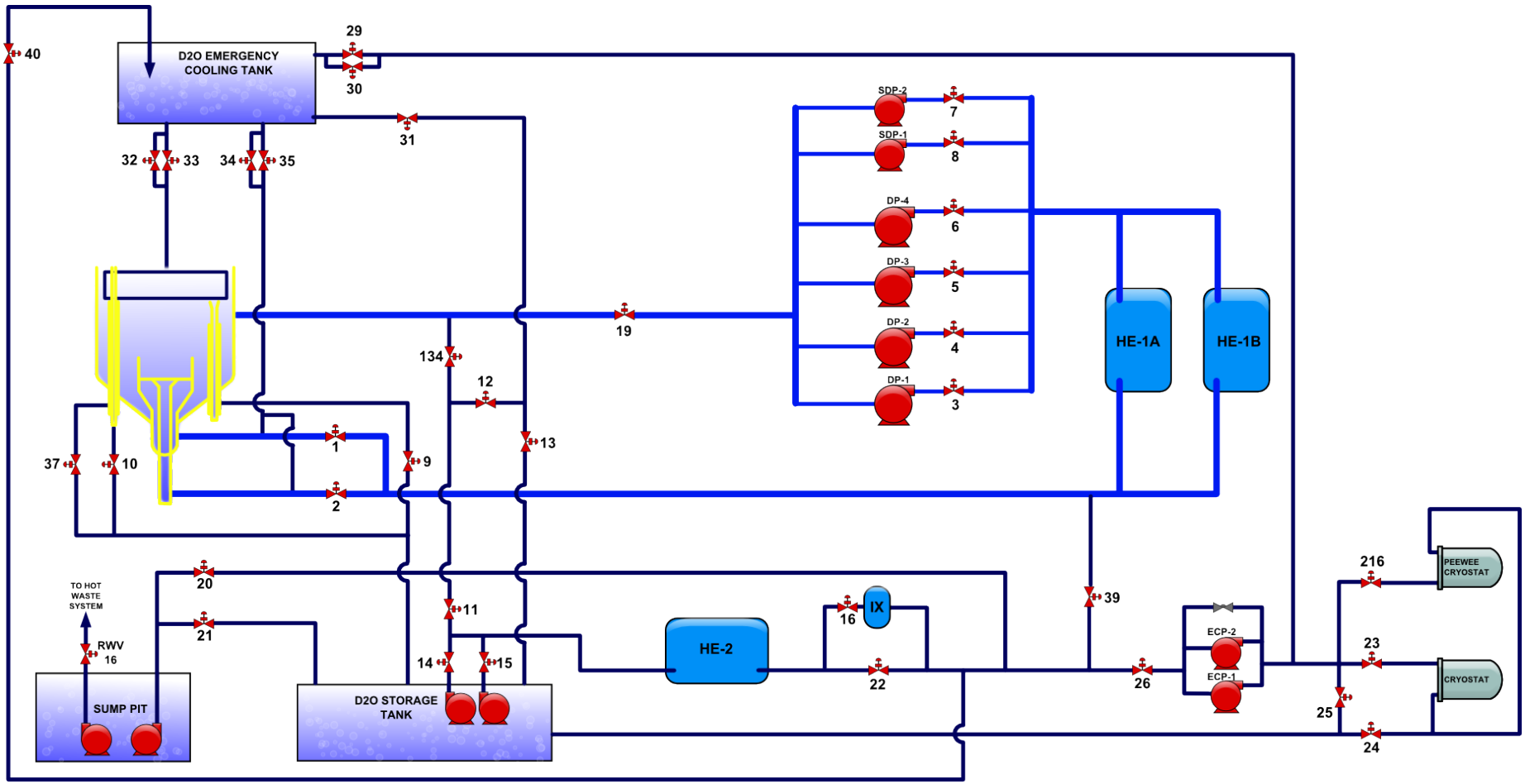
Displaying Data

- How should all of this reactor data be displayed?
- Diagrams of reactor systems are complicated, and can take a long time to decipher.

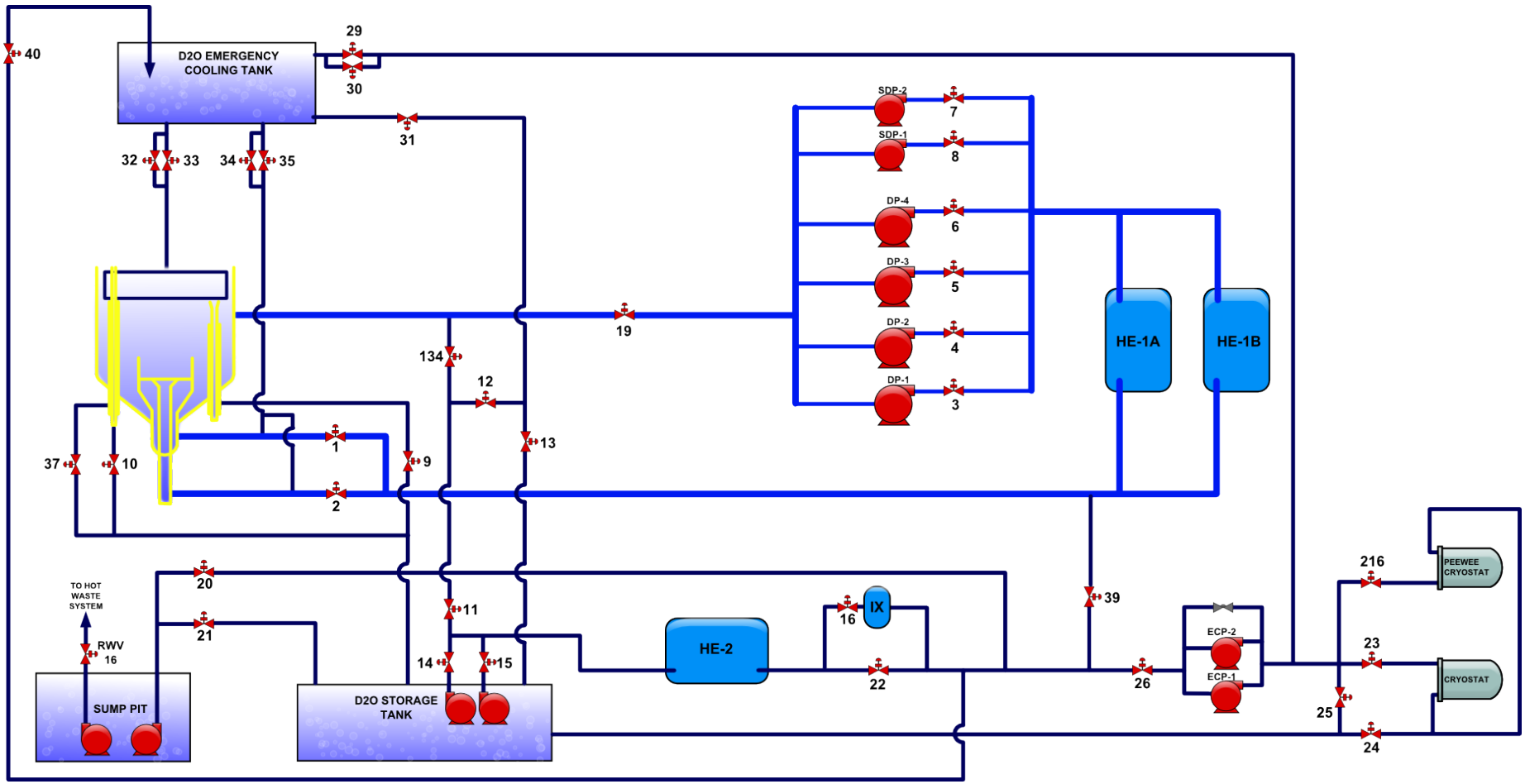

ORIGINAL DATE OF DRAWING: 02/26/81
REVISIONS
D_2O EMERGENCY COOLING TANK (3300 GALLONS)
INNER RESERVE TANK (800 GAL)
REACTOR VESSEL (4043 GAL)
THERMAL COLUMN TANK 240 GAL
HELIUM GAS HOLDER (100 Cu.Ft.)
D_2O STORAGE (14650 GALLONS)
D_2O STORAGE TANK PUMPS (75 G.P.M.)
HELIUM BLOWERS(HB) 21 C.F.M.
NOTES:
NATIONAL INSTITUTE OF STANDARDS & TECHNOLOGY
REACTOR RADIATION DIVISION
GAITHERSBURG, MARYLAND 20899
COMBINED PIPING AND INSTRUMENTATION DIAGRAM
FOR PRIMARY WATER (D_2O) AND HELIUM SWEEP GAS SYSTEMS
DRAWING NO.
E-60-035
LEGEND:
1. VALVES
2. CONTROLLERS
3. FITTINGS
4. FLOW DETECTORS

New mimics display key data visually, without as much clutter.

Data on Mimics

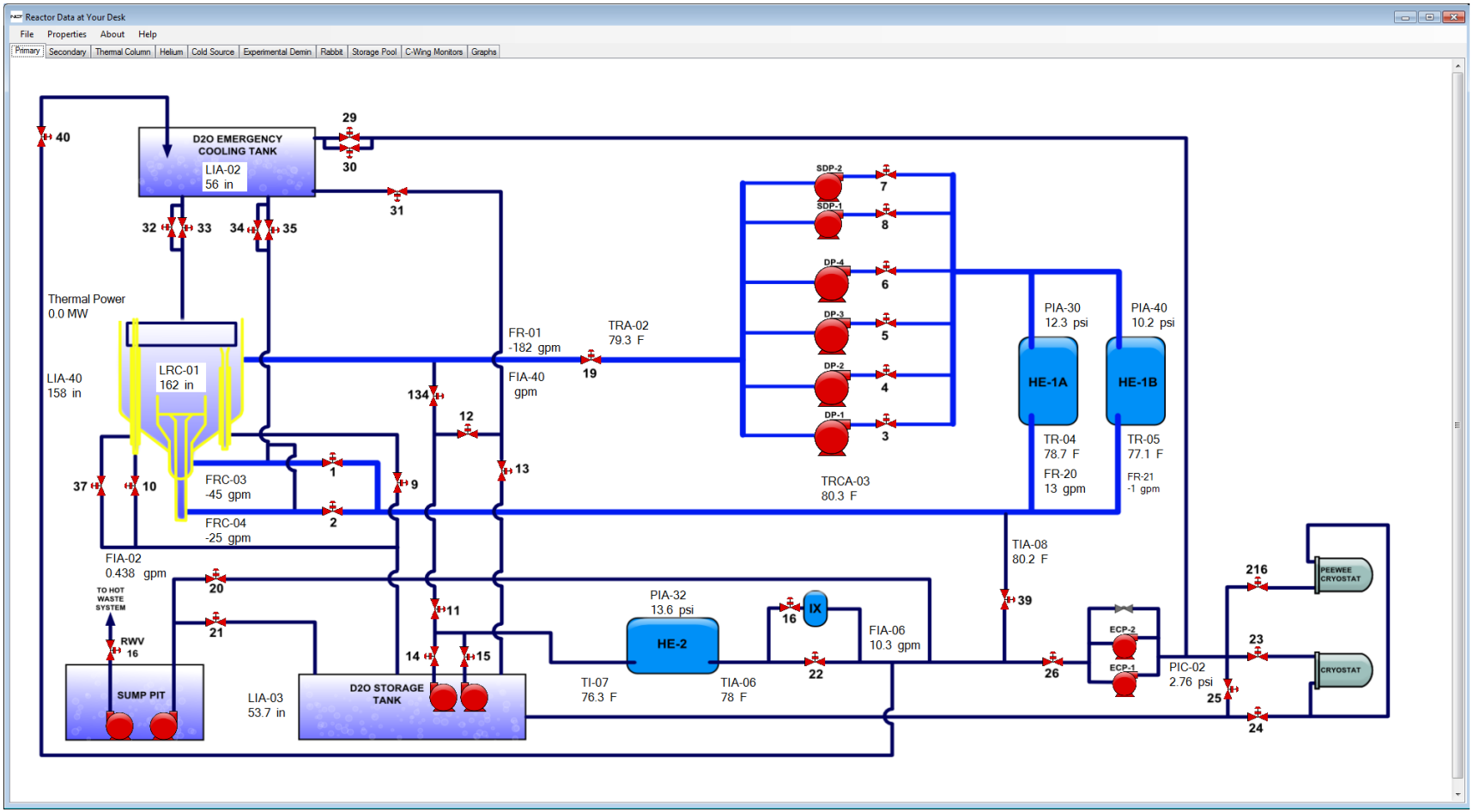


Data on Mimics

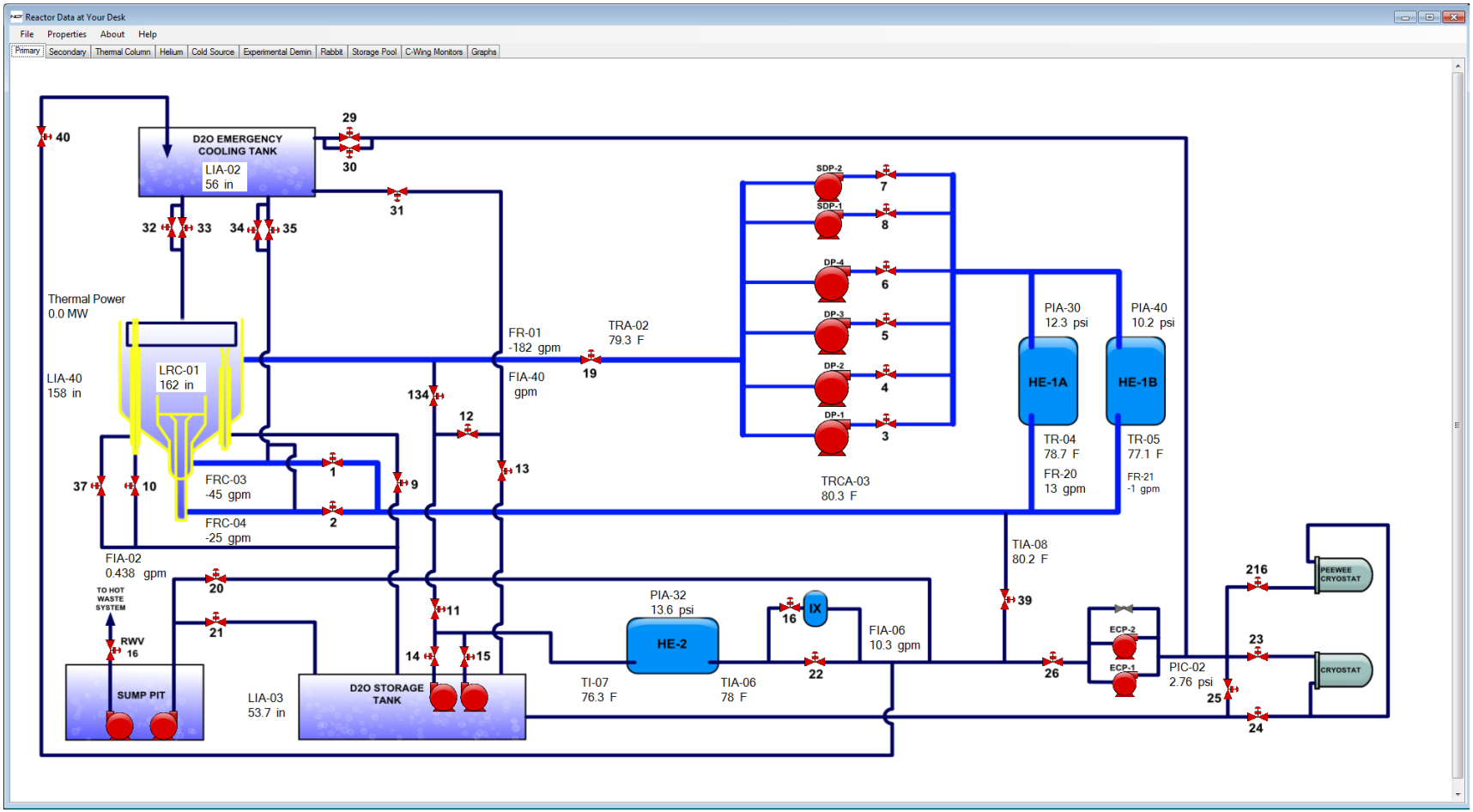


- The C#.NET and web program query current value data from the SQL database and display it in the relevant location.

Data on Mimics



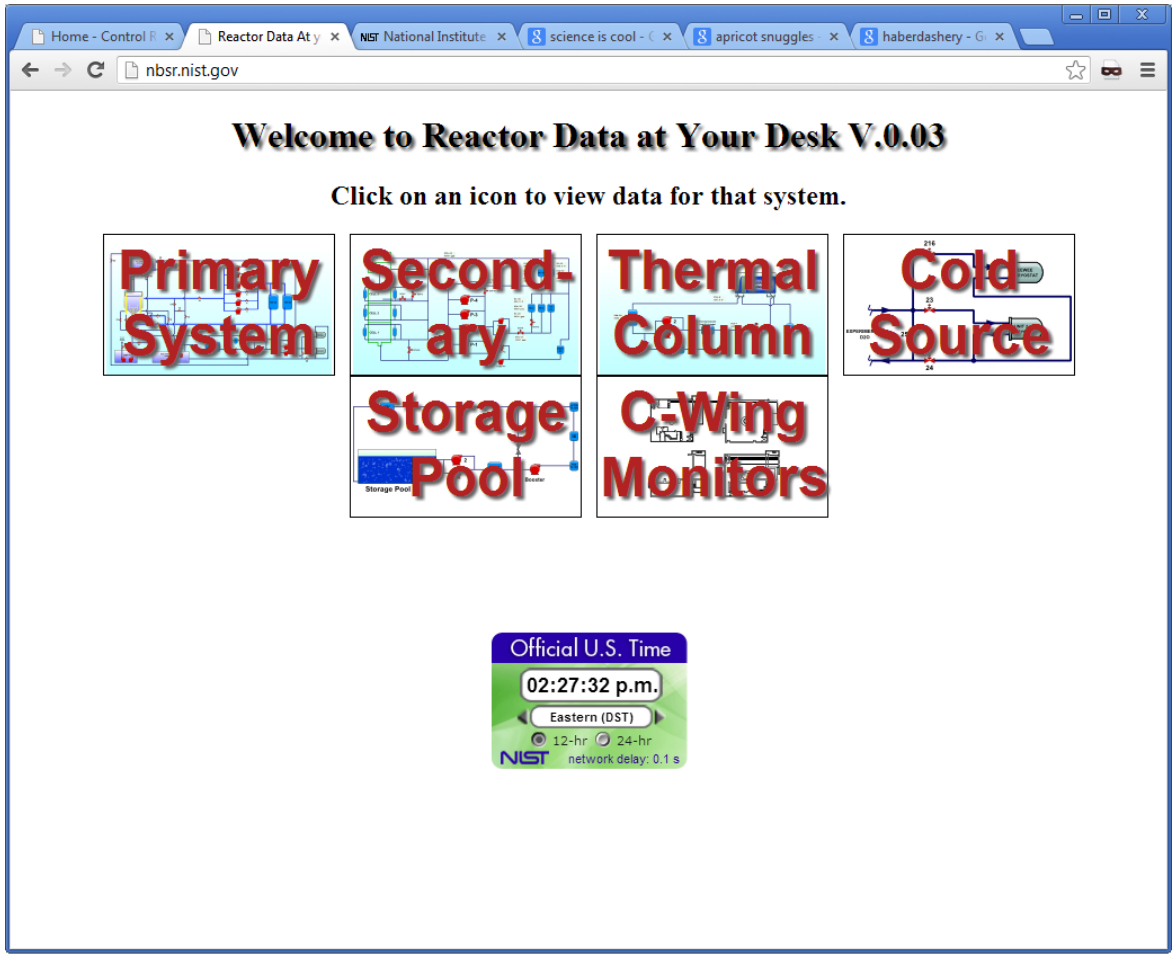
Data on Mimics



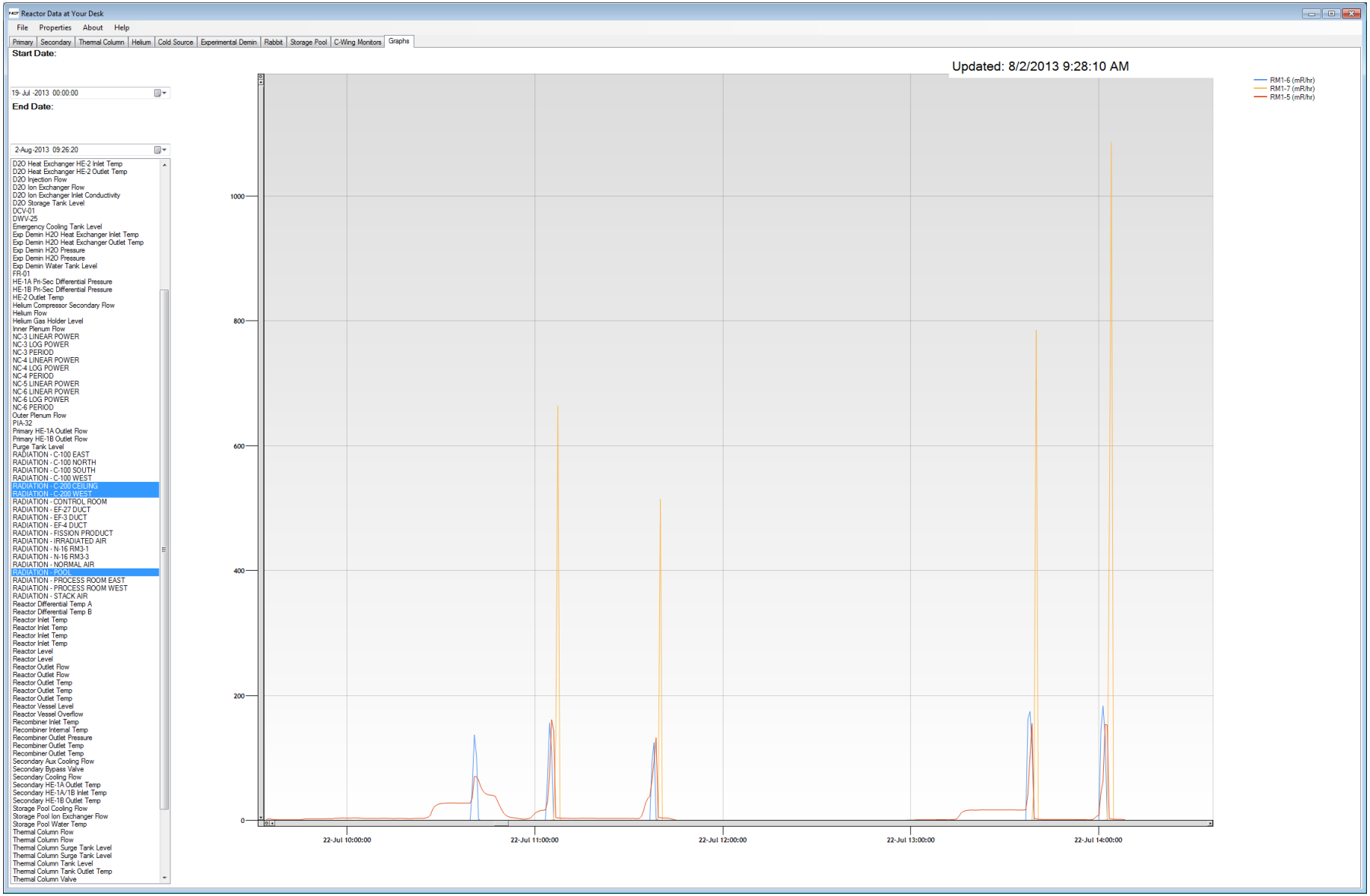
- The C#.NET program has tabs to select various systems. Clicking a label will display historical data.

Data on Mimics

- Website mimics are accessible through a password protected index page.



Graphs


Reactor Data at Your Desk
File
Properties
About
Help
Primary
Secondary
Thermal Column
Helium
Cold Source
Experimental Demin
Rabbit
Storage Pool
C-Wing Monitors
Graphs
Start Date:
19- Jul -2013 00:00:00
End Date:
2-Aug-2013 09:26:20
D2O Heat Exchanger HE-2 Inlet Temp
D2O Heat Exchanger HE-2 Outlet Temp
D2O Injection Flow
D2O Ion Exchanger Flow
D2O Ion Exchanger Inlet Conductivity
D2O Storage Tank Level
DCV-01
DWV-25
Emergency Cooling Tank Level
Exp Demin H2O Heat Exchanger Inlet Temp
Exp Demin H2O Heat Exchanger Outlet Temp
Exp Demin H2O Pressure
Exp Demin H2O Pressure
Exp Demin Water Tank Level
FR-01
HE-1A Pri-Sec Differential Pressure
HE-1B Pri-Sec Differential Pressure
HE-2 Outlet Temp
Helium Compressor Secondary Flow
Helium Flow
Helium Gas Holder Level
Inner Plenum Flow
NC-3 LINEAR POWER
NC-3 LOG POWER
NC-3 PERIOD
NC-4 LINEAR POWER
NC-4 LOG POWER
NC-4 PERIOD
NC-5 LINEAR POWER
NC-6 LINEAR POWER
NC-6 LOG POWER
NC-6 PERIOD
Outer Plenum Flow
PIA-32
Primary HE-1A Outlet Flow
Primary HE-1B Outlet Flow
Purge Tank Level
RADIATION - C-100 EAST
RADIATION - C-100 NORTH
RADIATION - C-100 SOUTH
RADIATION - C-100 WEST
RADIATION - C-200 CEILING
RADIATION - C-200 WEST
RADIATION - CONTROL ROOM
RADIATION - EF-27 DUCT
RADIATION - EF-3 DUCT
RADIATION - EF-4 DUCT
RADIATION - FISSION PRODUCT
RADIATION - IRRADIATED AIR
RADIATION - N-16 RM3-1
RADIATION - N-16 RM3-3
RADIATION - NORMAL AIR
RADIATION - POOL
RADIATION - PROCESS ROOM EAST
RADIATION - PROCESS ROOM WEST
RADIATION - STACK AIR
Reactor Differential Temp A
Reactor Differential Temp B
Reactor Inlet Temp
Reactor Inlet Temp
Reactor Inlet Temp
Reactor Inlet Temp
Reactor Level
Reactor Level
Reactor Outlet Flow
Reactor Outlet Flow
Reactor Outlet Temp
Reactor Outlet Temp
Reactor Outlet Temp
Reactor Vessel Level
Reactor Vessel Overflow
Recombiner Inlet Temp
Recombiner Internal Temp
Recombiner Outlet Pressure
Recombiner Outlet Temp
Recombiner Outlet Temp
Secondary Aux Cooling Flow
Secondary Bypass Valve
Secondary Cooling Flow
Secondary HE-1A Outlet Temp
Secondary HE-1A/1B Inlet Temp
Secondary HE-1B Outlet Temp
Storage Pool Cooling Flow
Storage Pool Ion Exchanger Flow
Storage Pool Water Temp
Thermal Column Flow
Thermal Column Flow
Thermal Column Surge Tank Level
Thermal Column Surge Tank Level
Thermal Column Tank Level
Thermal Column Tank Outlet Temp
Thermal Column Valve
Updated: 8/2/2013 9:28:10 AM
RM1-6 (mR/hr)
RM1-7 (mR/hr)
RM1-5 (mR/hr)
1000
800
600
400
200
0
22-Jul 10:00:00
22-Jul 11:00:00
22-Jul 12:00:00
22-Jul 13:00:00
22-Jul 14:00:00

Graphs

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Chart Features

1. Link with mimics
2. Interface with mySQL
3. Date Range Selection
4. Multiple Traces/Tags
5. Sparse Data
6. Save/Print
7. Export

Accomplished Through

1. C# loops on lists
2. dbConnect C# class
3. Timestamp logic in SQL statement
4. Manipulating Lists of data in C#
5. SELECT every nth row
6. WinForms Chart class
7. C# Export Class

Graphs

Why is this useful?

- Troubleshooting

Graphs

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- Ease of use

Graphs

Why is this useful?

- Troubleshooting
- Ease of use
- Lots of data in one place

Extensions

- Build a more robust database and UI program.
- Make changes to interface based on user feedback.
- Add the rest of the control room values.

Acknowledgements

- Joe Reyenga
- Mike Middleton
- Bob, Mike Rowe, Paul and Dennis
- Dr. Huber, Dr. Dimeo
- SURF Directors
- Grant and Max